CBP Tech Note-387

Electron-Cloud Build-Up Simulations for the MI RFA: A Status Report

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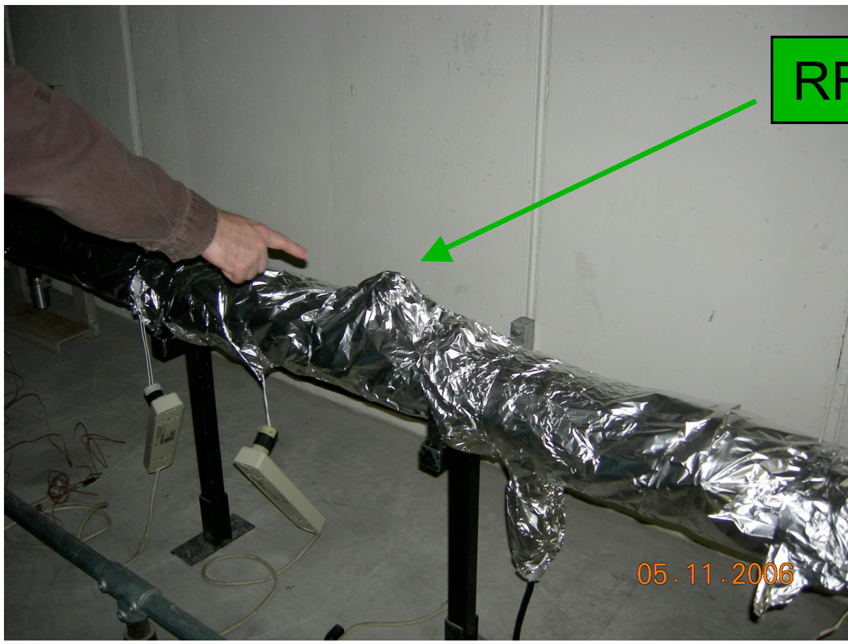
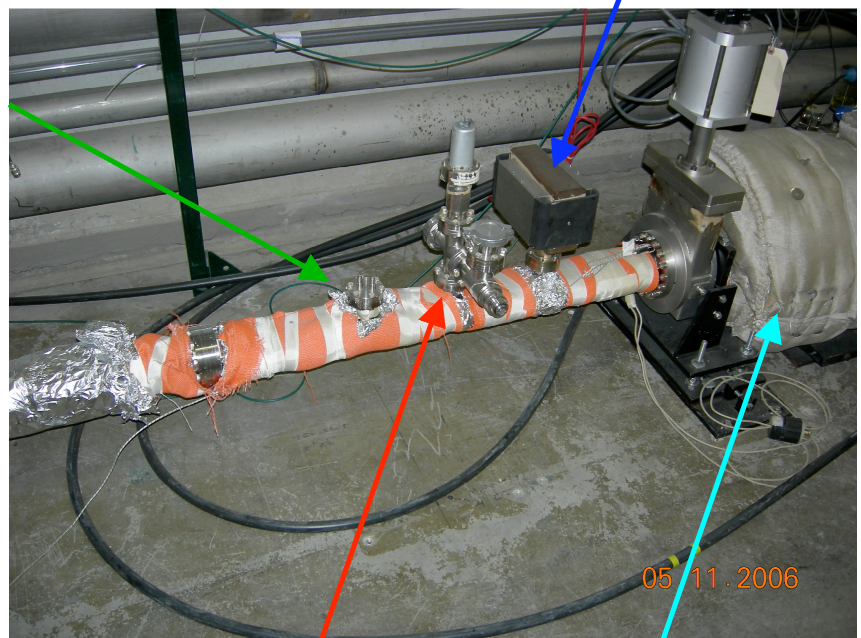
RFA detectors

RFA e⁻ detectors (ANL design; Rosenberg-Harkay) measure flux and energy spectrum

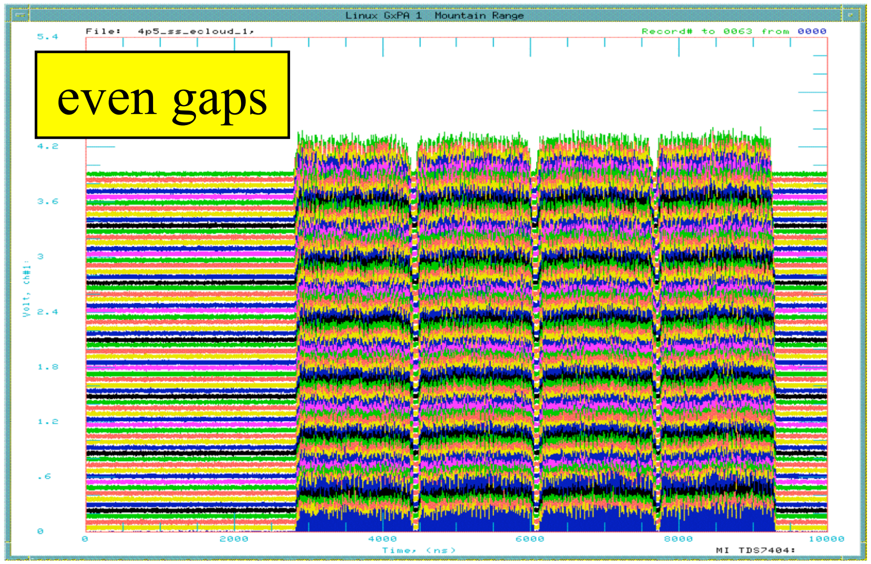
Main Injector

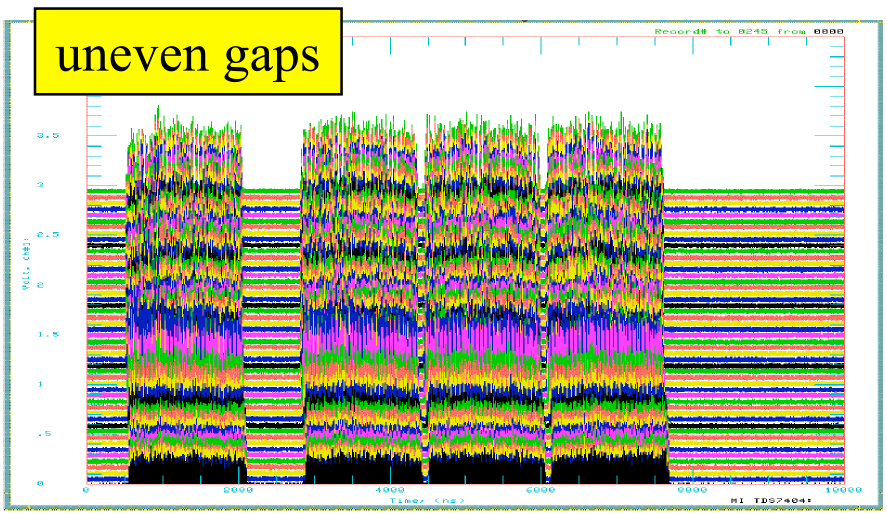


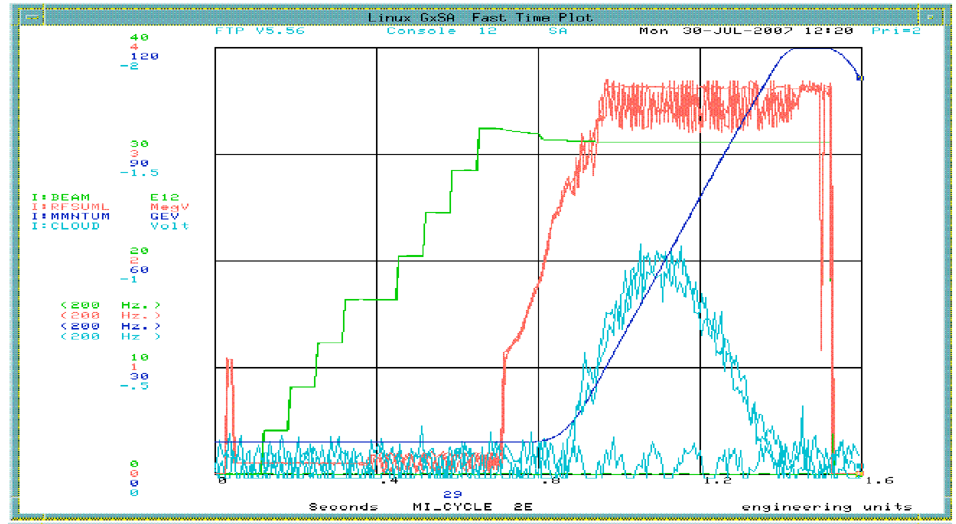
Tevatron

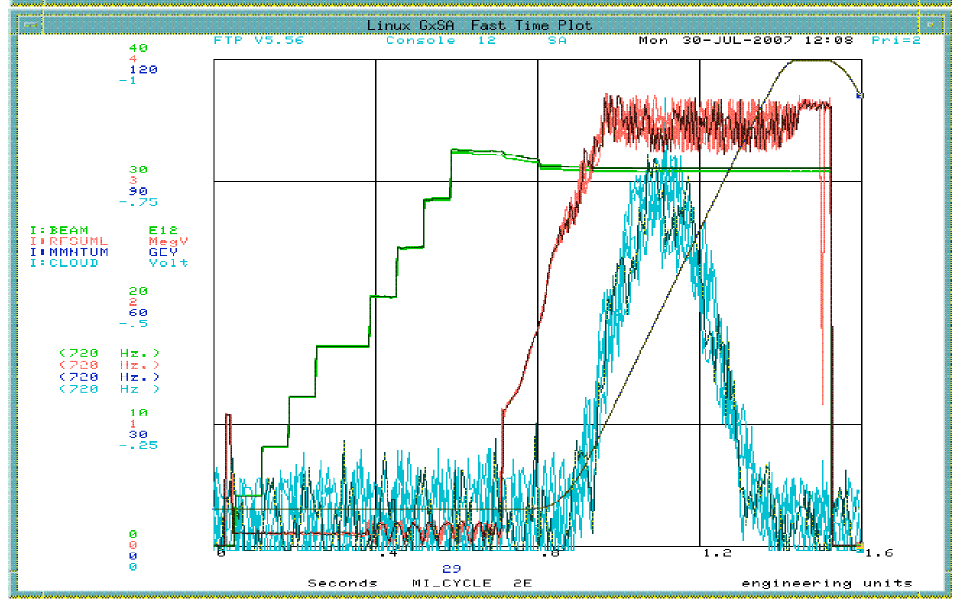


Example: 4 trains, N_b=(9.1–9.5)e10
(from I. Kourbanis report, ~26 Aug. 2007)









Bunch length during ramp
(from I. Kourbanis report, ~26 Aug. 2007)

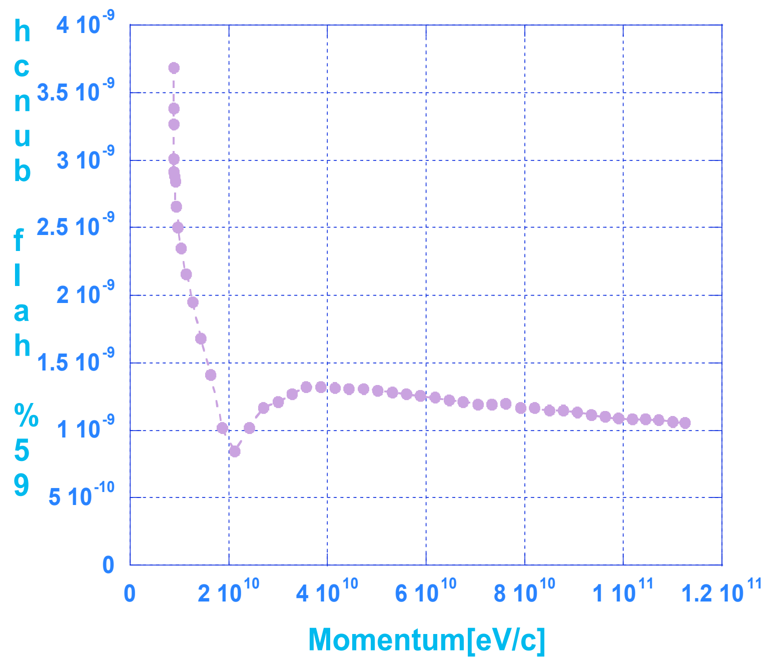
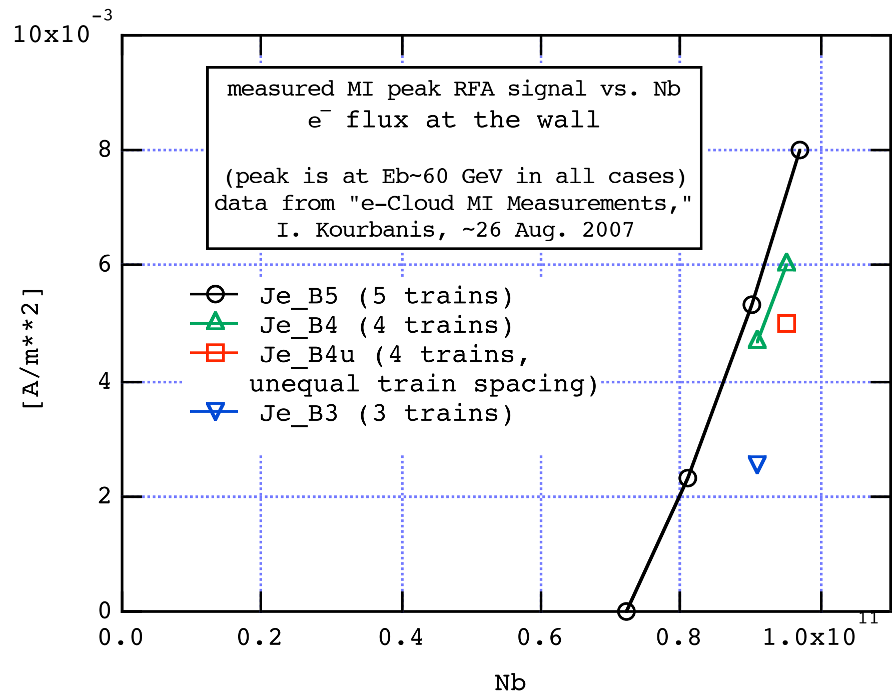


Fig. 9: Bunch length vs. momentum for 9.5E10 p/bunch. The bunch length in the above plot represents the average 95% half bunch length.

Summary of RFA measurements
(extracted from I. Kourbanis report, ~26 Aug. 2007)

- For this exercise, take measured RFA signal only at E_b=60 GeV
  - this is the peak signal for all cases
- To convert RFA voltage signal to e^- flux (R. Zwaska):
  - assume 1 μA/V
  - divide by 1.5 cm^2
    - this assumes 30% area efficiency

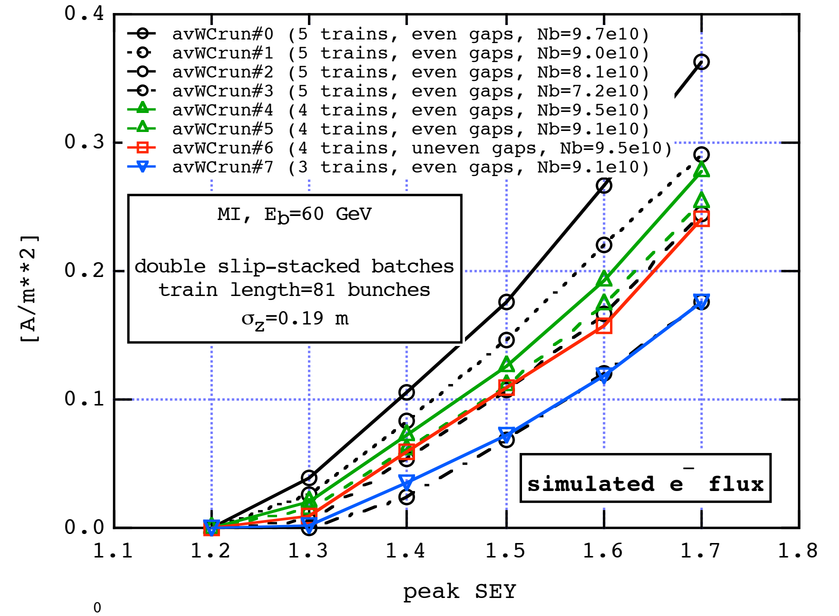
e^- flux at RFA vs. N_b for various fill patterns (E_b=60 GeV all cases)

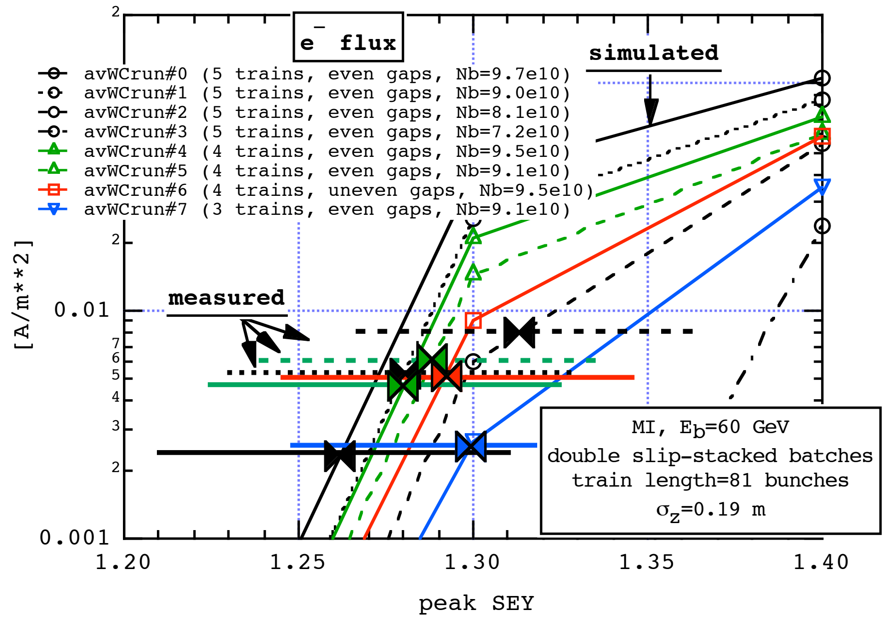


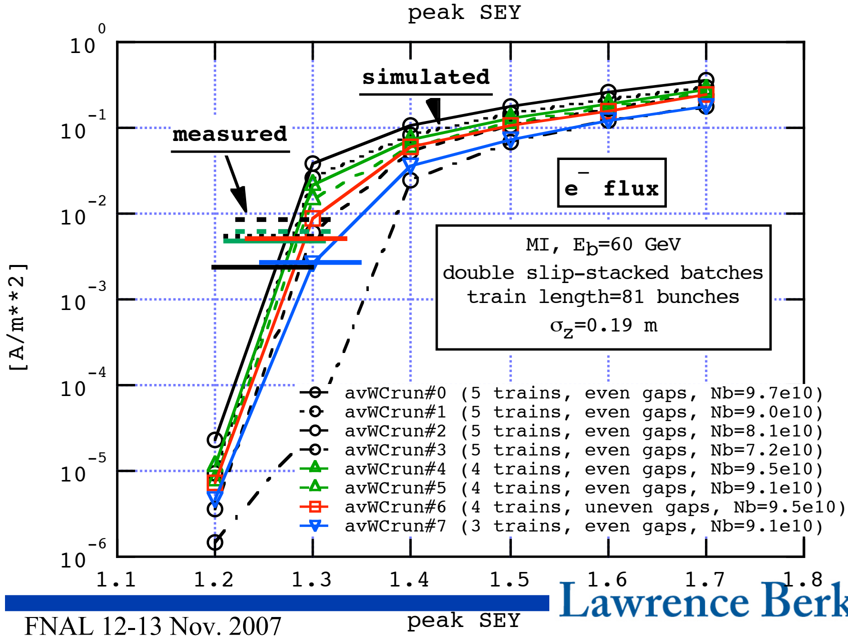
"POSINST" code build-up simulations

- Use actual fill pattern for each case
  - —81 bunches/train
  - —train gap = five 53-MHz empty buckets
    - except for "UG" case: one long gap of 42 empty buckets
- Use actual values for N_b, σ_x, σ_y, σ_z
- So far, done only E_b=20, 45, 60 and 90 GeV
- Field-free pipe, 7.3 cm radius
- Average ecloud flux and density over 1 turn
  - —this is long enough for sensible time averages

Electron flux vs. peak SEY at E_b=60 GeV

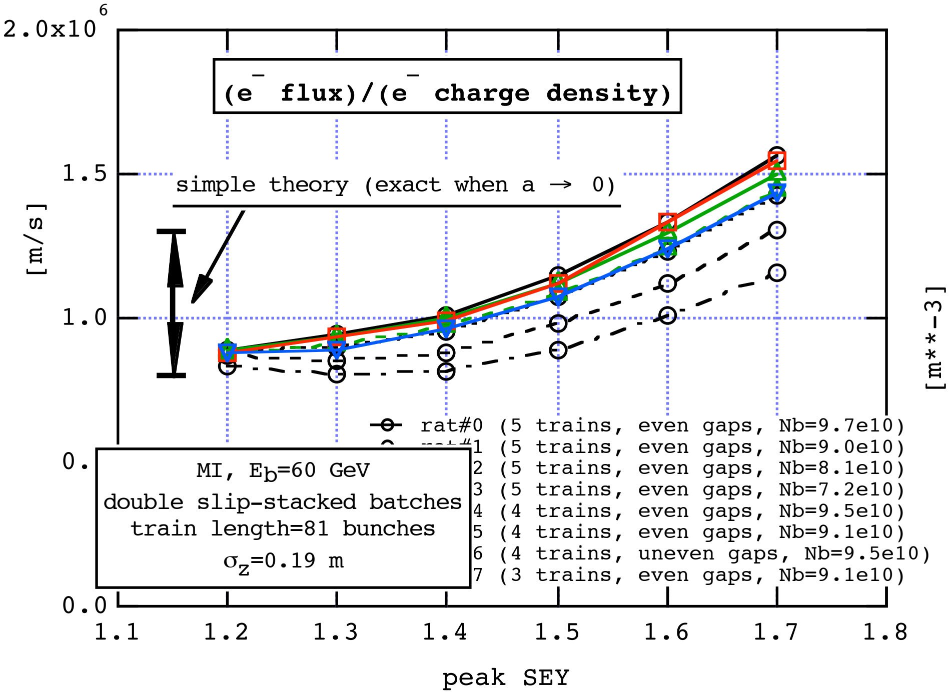


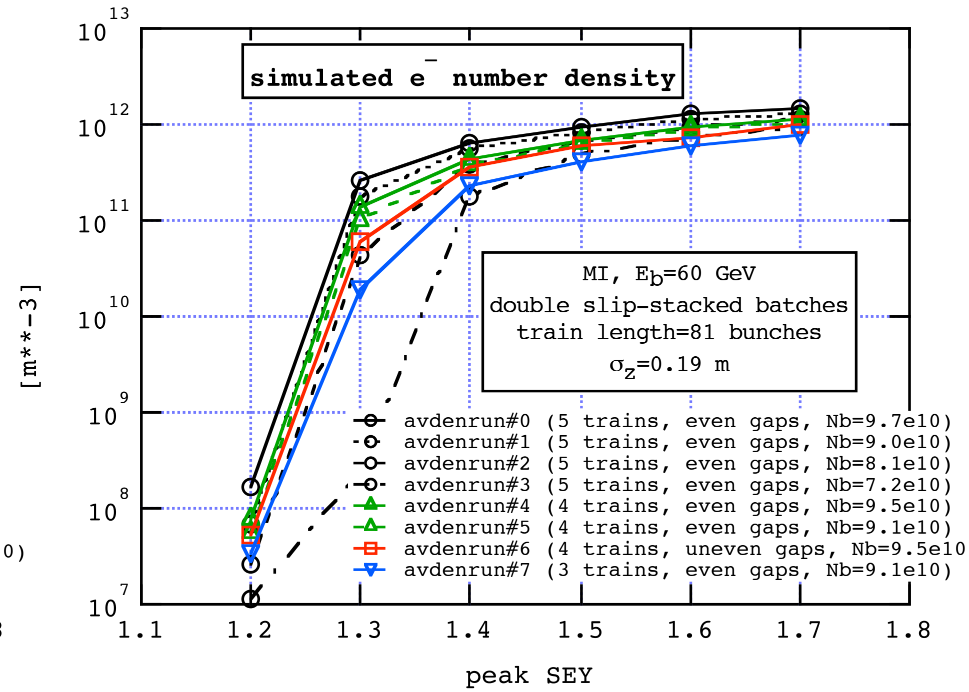




- Nicely clustered set of solutions for δ_{max}
  - —Indicates consistency in the model and the measurements

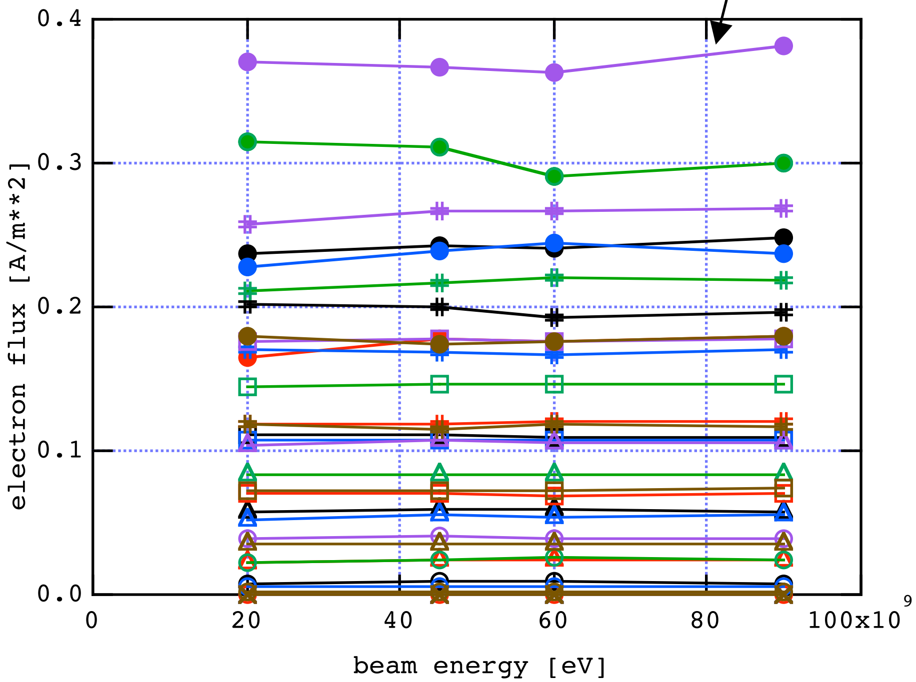
Furthermore…





- Flux/density consistent with simple theory, as expected
  - — $J_e/\rho_e \approx a/(2t_b)$ (R. Zwaska)
    - This becomes exact in the limit $a \to 0$
- From J_e results (previous slide), conclude $n_e \sim 10^{10}\text{-}10^{11}\ m^{-3}$

However…



Qualitatively inconsistent with measurements

- Simulated results insensitive to E_b
  - Qualitatively similar results when vary E_{max} and SE energy spectrum
- E_b enters only indirectly in the model, primarily through σ_z
  - Therefore, not too surprising (to me) to see weak dependence on E_b

Conclusions

- Nice, consistent set of results at a given beam energy
  - — Results from E_b=60 GeV data imply δ_{max}~1.25–1.35 and n_e~10^{10}–10^{11} m^{-3} on average
    - Caveat: actual numbers depend on other assumed SEY parameters, eg., E_{max} and SE emission energy spectrum
    - But qualitative picture doesn't change much
- However, simulations ~insensitive to E_b
  - — In qualitative disagreement with measurements
- What next:
  - — Methodically assess one set of results for J_e vs. σ_z when one makes Δt smaller and smaller
- Is it possible that I am not simulating the real situation?
  - — eg., could it be that stray B-fields during the ramp are messing up the RFA measurements?
- Can you stop the ramp and measure J_e and dN/dE at fixed E_b?